The Peripheral LED Monitoring System for KamLAND

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A total of 30 fast light emitting diode (LED) modules developed at LBNL are mounted at the outer peripheral shell (spherical, 8.5 m in radius) of the KamLAND detector. The primary purpose of the PLED system is to monitor the long term timing stability of the detector as well as providing photo multiplier tube (PMT) timing-offset measurements in additional to laser-based light sources. One major advantage of the PLED system is that it is permanently mounted inside the detector without requiring any source deployment, minimizing the neutrino data-taking down-time. Since the source positions are well known, they can be used for testing the reconstruction accuracy and efficiency of the various vertex fitters as well.

The computer controlled and externally triggered PLED modules are typically firing at a rate of ∼100 Hz during a calibration run. Figure 1 shows the detected light patterns as seen by the PMTs. The main illuminated region corresponds to tubes that are facing the PLED directly on the opposite side of the detector, within a half cone angle of about 15°. Since the PLED locations follow closely to detector symmetry, each PMT can be calibrated with at least 2 different PLEDs. This provides a redundant check when analyzing the data. The time when the i^{th} tube fired, T_i, with respect to the external trigger reference time, T_{ref}, is extracted from the corresponding digitally recorded waveforms. The direct optical path from a PLED to a PMT is calculated from known geometry of the detector. The PMT time offset, $T0_i$, due to possible variations in cable length, PMT high voltage setting, electronics as well as intrinsic PMT transit time etc., is obtained after correcting for the calculated flight path difference. The variable PLED output light intensity is computer controlled and is typically set to a level corresponding to single PE detection for the PMTs. Fig.2 shows a comparison of the T0 offset values deduced from the PLED system and a laser source deployed at the center of the detector. The agreement is good. Only a limited amount of PLED evaluation data has been taken so far. More studies are needed to establishing the sensitivity of the system with respect to major variations in detector characteristics.

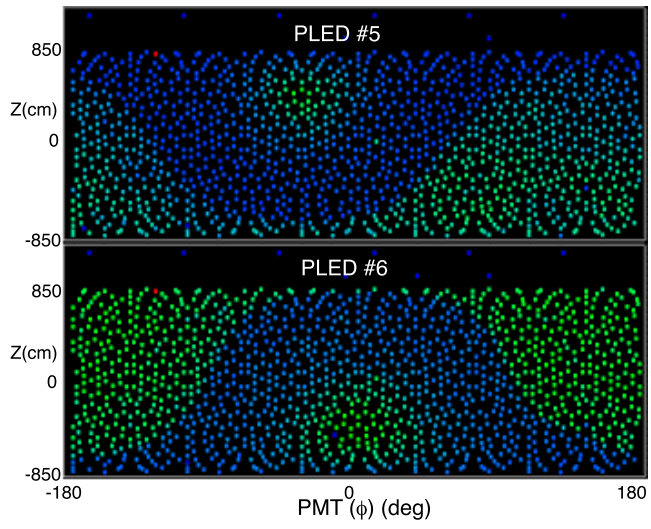

FIG. 1: The detected light pattern for 2 PLED at different locations . Each dot is a PMT characterized by its ϕ angle and the z-coordinate. The illuminated regions are indicated by green.

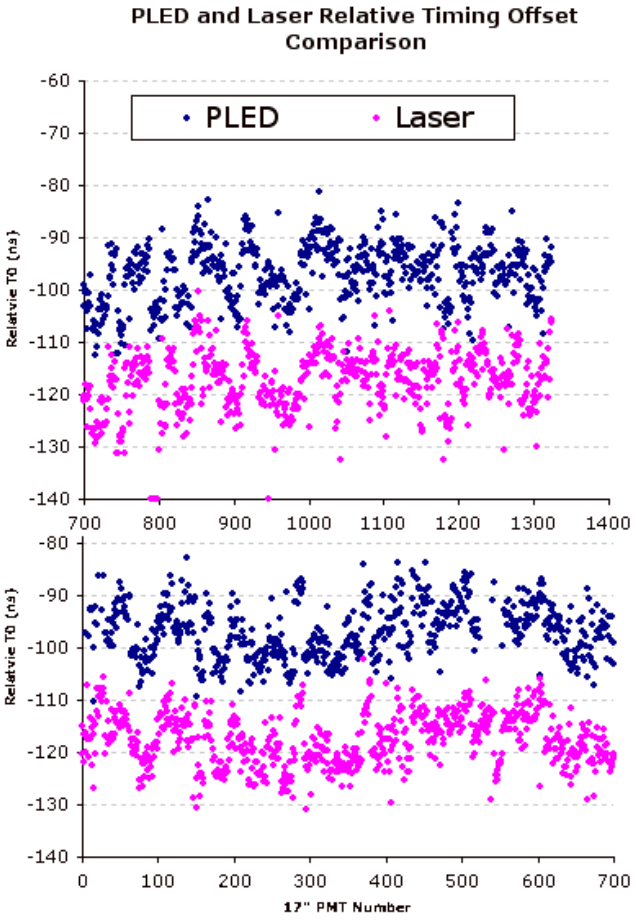

FIG. 2: Comparison of PMT relative time-offset constants deduced from the PLED and laser calibration sources. Only relative values are shown.